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FOR

DOCKET NO. 57139-5052

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Installation and maintenance of the control shift cable is complicated and requires the elimination of any kinks and bends in the cable that can result in additional frictional force between the cable and the sleeve.

5 To overcome the disadvantages of cable operated gear shift systems, hydraulically operated systems have been proposed. However, the problem with the known hydraulic gear shift systems is that the mechanisms used for indexed shifting are less sophisticated and imprecise. Accordingly, it is  
10 desirable to provide a hydraulic gear shift mechanism having a control device that provides precise positioning for indexed shifting.

Another disadvantage of known hydraulically operated gear shift systems is that if the system needs an adjustment, an  
15 end point adjustment is typically made at the slave cylinder assembly to adjust the initial position of the slave piston. Given that the slave cylinder assembly is located near the derailleur, it is inconvenient to a bicycle rider to make an adjustment at that location. Accordingly, it is desirable to  
20 provide an adjuster at a location that is easily accessible to the rider.

#### Summary of the Preferred Embodiments

25 A hydraulic shift gear mechanism for a bicycle having a positioning mechanism for controlling the motion of the piston of a master cylinder assembly is disclosed, wherein the master cylinder assembly is in communication with a slave cylinder for operation of a derailleur. The positioning mechanism preferably includes a pivot shaft spaced apart from the  
30 handlebar, a rotating member rotatable about the pivot shaft, a push mechanism for rotating the rotating member in a first direction and a return mechanism for rotating the rotating member in a second direction. The push mechanism preferably includes a first latch segment which engages a corresponding

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push pawl to rotate the rotating member. The return mechanism preferably comprises a second latch segment and a return pawl, the return pawl having a first claw and a second claw which alternately engage the second latch segment. The rotating member is preferably operatively engaged with the piston of the master cylinder, wherein the rotation of the rotating member translates to an axial motion of the piston rod. In a more preferred embodiment of the invention, an adjuster piston is threadingly engaged with the master cylinder assembly for adjusting the initial position of the slave cylinder.

Other objects, features and advantages of the present invention will become apparent to those skilled in the art from the following detailed description. It is to be understood, however, that the detailed description and specific examples, while indicating preferred embodiments of the present invention, are given by way of illustration and not limitation. Many changes and modifications within the scope of the present invention may be made without departing from the spirit thereof, and the invention includes all such modifications.

#### Brief Description of the Drawings

The invention may be more readily understood by referring to the accompanying drawings in which:

FIG. 1 is a perspective front view of a preferred embodiment of the shift control device of the present invention as attached to a bicycle handlebar;

FIG. 2 is an exploded perspective view of a preferred embodiment of the positioning mechanism of the present invention;

FIG. 3 is a top cross-sectional view of the positioning mechanism of the present invention in a neutral position;

FIG. 4 is a side cross-sectional view of a preferred embodiment of the master cylinder assembly of the present invention;

FIG. 5 is a perspective view of a preferred embodiment of the slave cylinder assembly of the present invention as attached to a derailleur;

FIGS. 6a-6e are top cross-sectional views of the positioning mechanism of the present invention in operation in an upshift direction; and

FIGS. 7a-7d are top cross-sectional views of the positioning mechanism of the present invention in operation in a downshift direction.

Like numerals refer to like parts throughout the several views of the drawings.

#### Detailed Description of the Preferred Embodiments

Figure 1 depicts a preferred embodiment of the shift control device 100 of the present invention as attached to a bicycle handlebar 200. In a preferred embodiment of the invention, the shift control device 100 includes a bracket or base member 110, a master cylinder assembly 300 and a positioning mechanism 400. The handlebar 200 is preferably a flat-bar type handlebar having a cylindrical body that extends substantially along a handlebar axis 210. The bracket 110 is secured to the handlebar 200 of the bicycle preferably by a clamp band 120 and a bolt and nut assembly 121. A fluid conduit 500 connects the master cylinder assembly 300 to the slave cylinder assembly, as will be discussed in further detail below.

The positioning mechanism 400 preferably includes a control lever 405 that, as described in further detail below, controls the operation of the positioning mechanism 400. In a preferred embodiment of the invention, the control lever 405



piston rod 332 of the master cylinder assembly 300. The axial movement of the rack gear 450 results in a corresponding movement of the piston rod 332 of the master cylinder assembly 300.

5 Referring to Figures 2 and 3, the positioning mechanism 400 preferably includes a fixed plate 480 and an operating plate 490. In a preferred embodiment of the invention, the fixed plate 480 is fixed to the bracket 110 and an upper support 481 is fixedly coupled to the fixed  
10 plate 480. The operating plate 490 is rotatably supported on the main pivot shaft 410 and biased in a neutral position by spring S4. The control lever 405 is preferably integral with the operating plate 490 such that the control lever 405 and operating plate 490 rotate together about the pivot shaft 410  
15 when the control lever 405 is operated.

To control the rotation of the latch plate 440, the positioning mechanism 400 includes a return pawl 460 and a push pawl 470 configured to engage latch plate 440. The return pawl 460 is rotatably supported on pivot shaft 461 and  
20 includes an abutment 462, a first claw 463 and a second claw 464. The pivot shaft 461 is fixedly attached to the bracket 110. The return pawl 460 is preferably biased in a counterclockwise direction by spring S2. The push pawl 470 is rotatably supported on pivot shaft 471 and biased toward in  
25 the counterclockwise direction by spring S3. Pivot shaft 471 is preferably fixed to the operating plat 490. A nut 482 and washer 483 are threaded onto the pivot shaft 410 to secure the components of the positioning mechanism 400 on the pivot shaft 410.

30 Figure 4 depicts a preferred embodiment of the master cylinder assembly 300 of the present invention. The master cylinder assembly 300 is preferably rigidly coupled to bracket 110. In a preferred embodiment, the master cylinder assembly 300 includes a main chamber 311, a bleed port 313, an

adjusting chamber 314 and a connecting port 312. A master piston 320 is disposed in the main chamber 311 and is sealed with a rubber ring 321. A main chamber plug 315 is threaded into the main chamber 311 for sealing the main chamber 311 and  
 5 slidably supporting piston rod 322. Piston rod 322 is preferably separable from the piston 320. A bleed nipple 340 preferably plugs the bleed port 313.

An adjusting piston 330 is disposed in the adjusting chamber 314 and is sealed with a rubber ring 331. An  
 10 adjusting chamber plug 316 is threaded into the adjusting chamber 314 for sealing the adjusting chamber 314 and supporting the adjusting piston rod 332. The adjusting piston rod 332 is preferably externally threaded, having threads that correspond to and engage with internal threads of the  
 15 adjusting chamber plug 316. The adjusting piston rod 332 is preferably connected to the adjusting piston 330 such that the threading of the piston rod 332 into or out of the adjusting chamber plug 316 changes the location of the adjusting piston 330 in the adjusting chamber 314.

The master cylinder assembly 300 and slave cylinder assembly 700 are in fluid communication via the fluid conduit 500. The fluid conduit 500 is preferably connected to the master cylinder 300 at the connecting port 312. Because the master cylinder assembly 300 and slave cylinder  
 20 assembly 700 are in fluid communication, the initial position of the slave piston may be adjusted by changing the position of the adjusting piston 330 in the adjusting chamber 314. For example, if the adjusting piston 330 is threaded further into the adjusting chamber 314, the fluid is moved through the  
 25 conduit 500 toward the slave cylinder assembly 700 causing the slave piston to be pushed back. One of the advantages of the present invention is that the end point adjustment of the  
 30 slave piston can be made conveniently at the handlebar.



As shown in Figure 5, in a preferred embodiment of the invention, the gear shift mechanism includes a four-bar linkage type derailleur 600 having a base member 610, a shifting member 640, an outer link 620 and an inner link 630. The base member is fixedly mountable on the bicycle frame and the shifting member 640 is connected to the base member 610 via the outer link 620 and inner link 630. The shifting member 640 is preferably biased toward the center line of the bicycle by a spring disposed inside of the four-bar linkage (not shown). A pulley cage 650, pivotably connected to the shifting member 640, rotatably supports a guide pulley 651 and a tension pulley 652.

A slave cylinder assembly 700 is operatively connected to the derailleur 600. In a preferred embodiment of the invention, the first end 701 of the slave cylinder assembly 700 is pivotably supported on the base member 610 and the second end 702 of the slave cylinder assembly 700 is pivotably supported on the arm 621 formed on the outer link 620. The slave cylinder assembly 700 preferably includes a slave cylinder chamber 710. The fluid conduit 500 is preferably connected to the slave cylinder assembly 700 at the connecting port 711. A slave piston 720 is disposed in the slave cylinder chamber 710 and is sealed with a rubber ring 721. A slave cylinder plug 713 sealingly engages the slave cylinder chamber 710 and slidingly supports the slave piston rod 730. Slave piston rod 730 is preferably separable from piston 720 and is not rigidly connected thereto.

Figure 3 depicts the positioning mechanism 400 of the present invention in a neutral position. In the neutral state, the operating plate 490 remains stationary because the spring S4 squeezes tab 491 formed on the operating plate 490 and tab 486 formed on the fixed plate 480, as best shown in Figure 2, from both sides. In the neutral position, the push pawl 470 rests on a ramp 484 peripherally formed on the fixed





latch 441 driving the pushing latch in the push direction P. The return pawl 460 disengages from the positioning latch teeth 442 and engages the tooth adjacent the previously engaged tooth. However, in the multi-step operation, the bicycle rider continues to rotate the control lever 405 causing the latch plate 440 to rotate further, and the return pawl 460 to continue to engage neighboring teeth 442 until the latch plate 440 ceases to rotate. In a preferred embodiment of the invention, the angle of rotation of the operating lever 405 in the push direction P is limited by the contact of abutment 494 on the operating plate 490 and protrusion 485 on the fixed plate 480.

Figures 7a through 7d depict the operation of the positioning mechanism 400 in the return or downshift direction. To operate the positioning mechanism 400 in the return direction R, the control lever 405 is rotated in the return or clockwise direction. As previously discussed, in a preferred embodiment of the invention, the release direction R is defined as the direction of movement of the control lever 405 from the neutral position away from the handlebar. Elements that do not related to the downshift operation are eliminated from the figures for ease of understanding.

Figure 7a depicts the positioning mechanism 400 of the present invention in a neutral position. Because the fluid in the fluid conduit 500 and the master piston 320 are biased by spring S1 and by the return spring of the derailleur 600 in the clockwise direction, the downshift operation can be performed by simply removing the force pushing on the master piston rod 322. As best shown in Figure 7b, the rotation of the operating plate 490 causes abutment 492 on the operating plate 490 to contact abutment 462 on the return pawl 460. Abutment 462 is configured such that contact with abutment 492 causes the first claw 463 of the return pawl 460 to disengage from the positioning latch 442. As the first claw 463

disengages from the positioning latch 442, the second claw 464 engages the positioning latch 442 to limit the rotation of the latch plate 440 to one step, as shown in Figure 7c. In a preferred embodiment of the invention, return pawl 460 produces an audible click when the second claw 464 engages the positioning latch 442. Moreover, the bicycle rider can feel the snap of the second claw 464 engaging the positioning latch 442. The audible click and the snapping motion alerts the rider that the return pawl 460 has advanced by one tooth. The rider can then return the operating lever to its neutral position, completing one step of a multi-step shift mechanism.

The drawings depict a positioning mechanism for a nine step shift operation. However, the present invention is not limited to a nine step shift operation and can be configured to vary the number of steps available. Furthermore, the description of the positioning mechanism and the corresponding drawings are directed to a positioning mechanism to be installed on the right hand side of a bicycle handlebar when viewed from the rider's perspective. The positioning mechanism installed on the left hand side of the bicycle handlebar is substantially the mirror image of the positioning mechanism of the right hand side.

The embodiments described above are exemplary embodiments of a hydraulic gear shift mechanism. Those skilled in the art may now make numerous uses of, and departures from, the above-described embodiments without departing from the inventive concepts disclosed herein. Accordingly, the present invention is to be defined solely by the scope of the following claims.